

CS302 - Data Structures

using C++

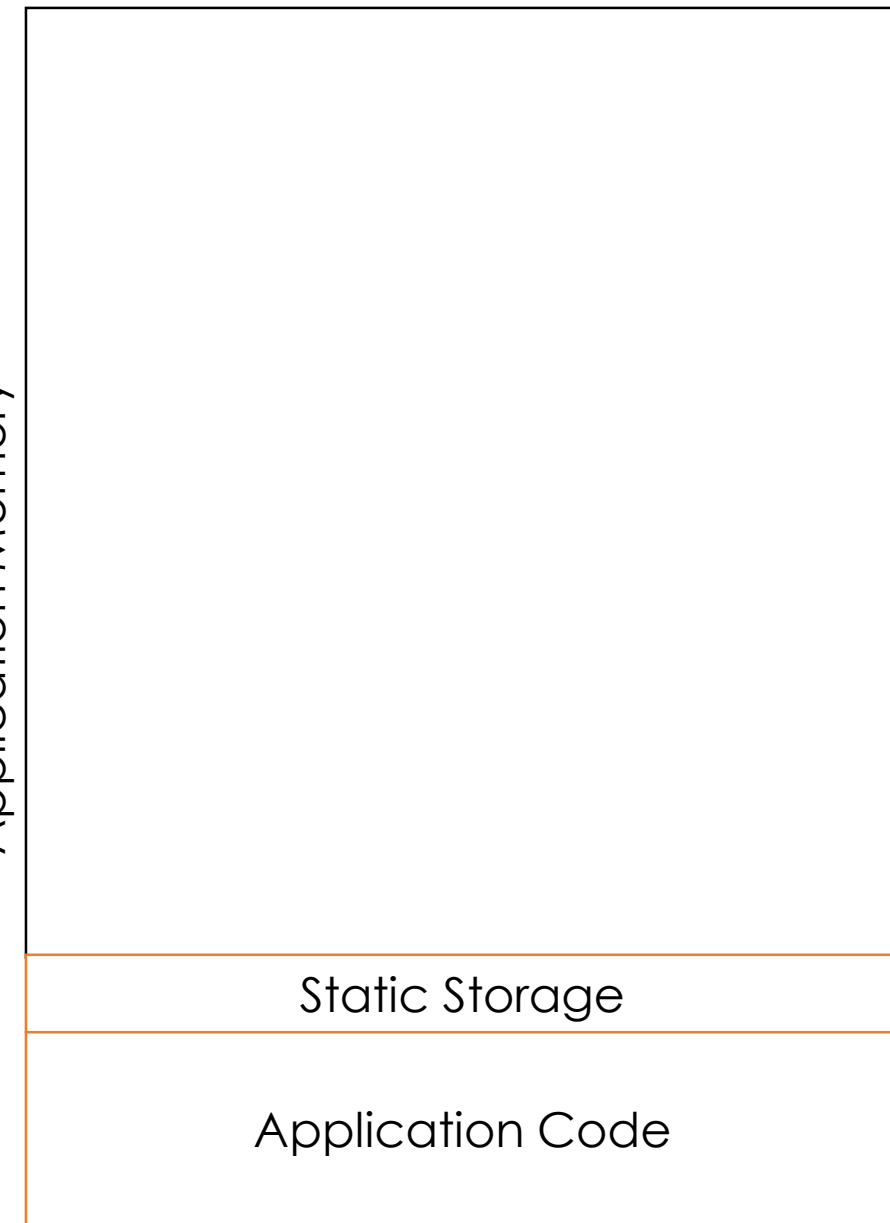
Topic: Memory Allocation

Kostas Alexis

Application Memory

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Application Memory



Application Memory

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Application Memory

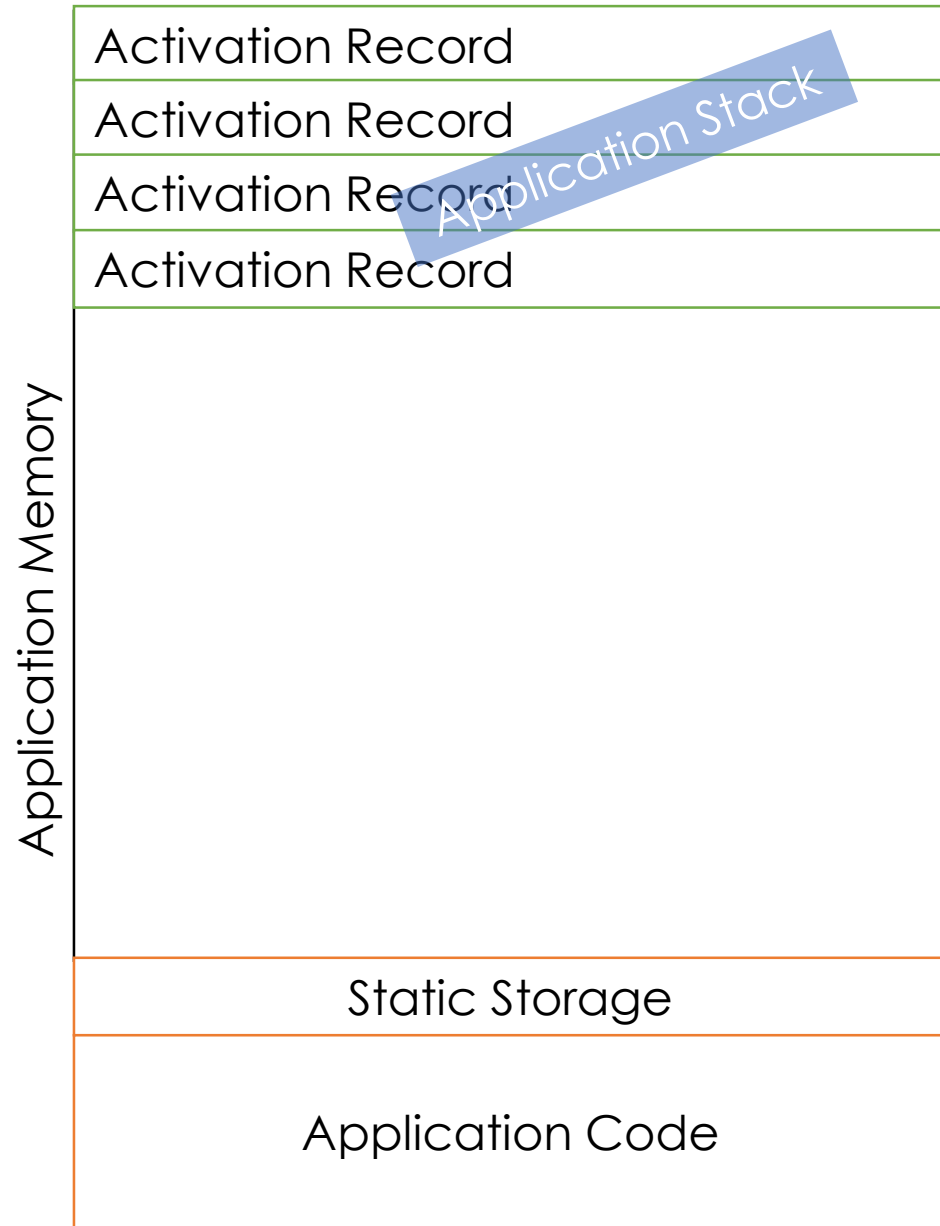
Activation Record
Activation Record
Activation Record
Activation Record

Static Storage

Application Code

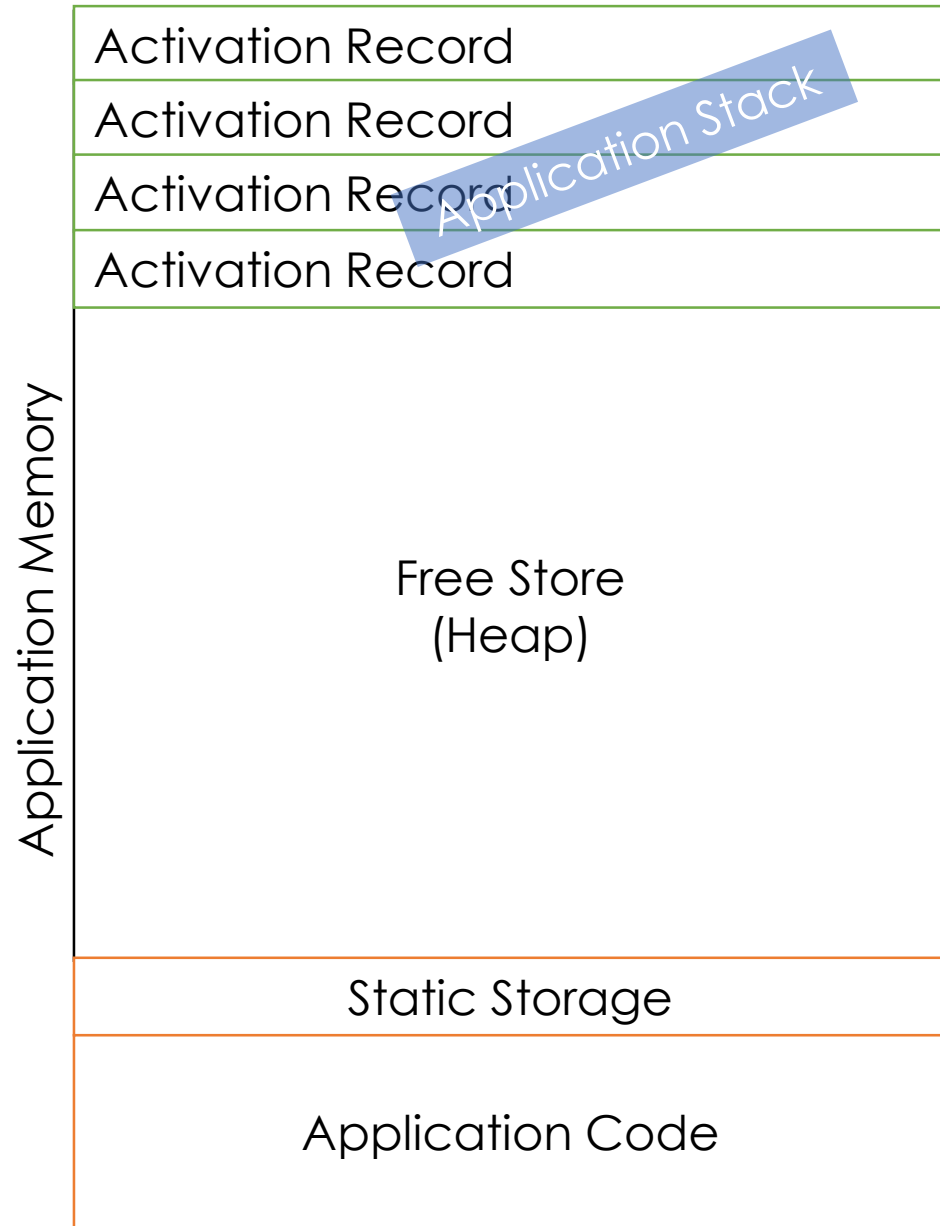
Application Memory

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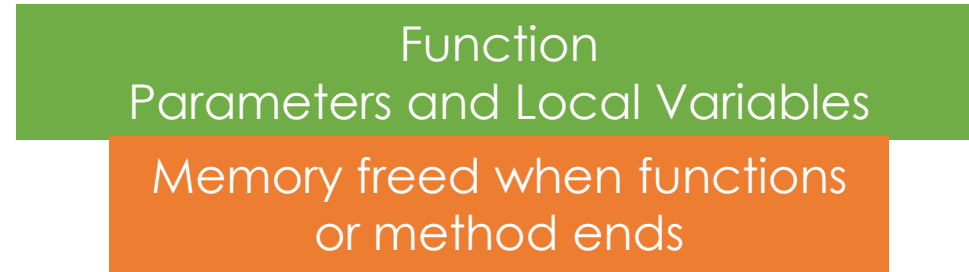
Application Memory

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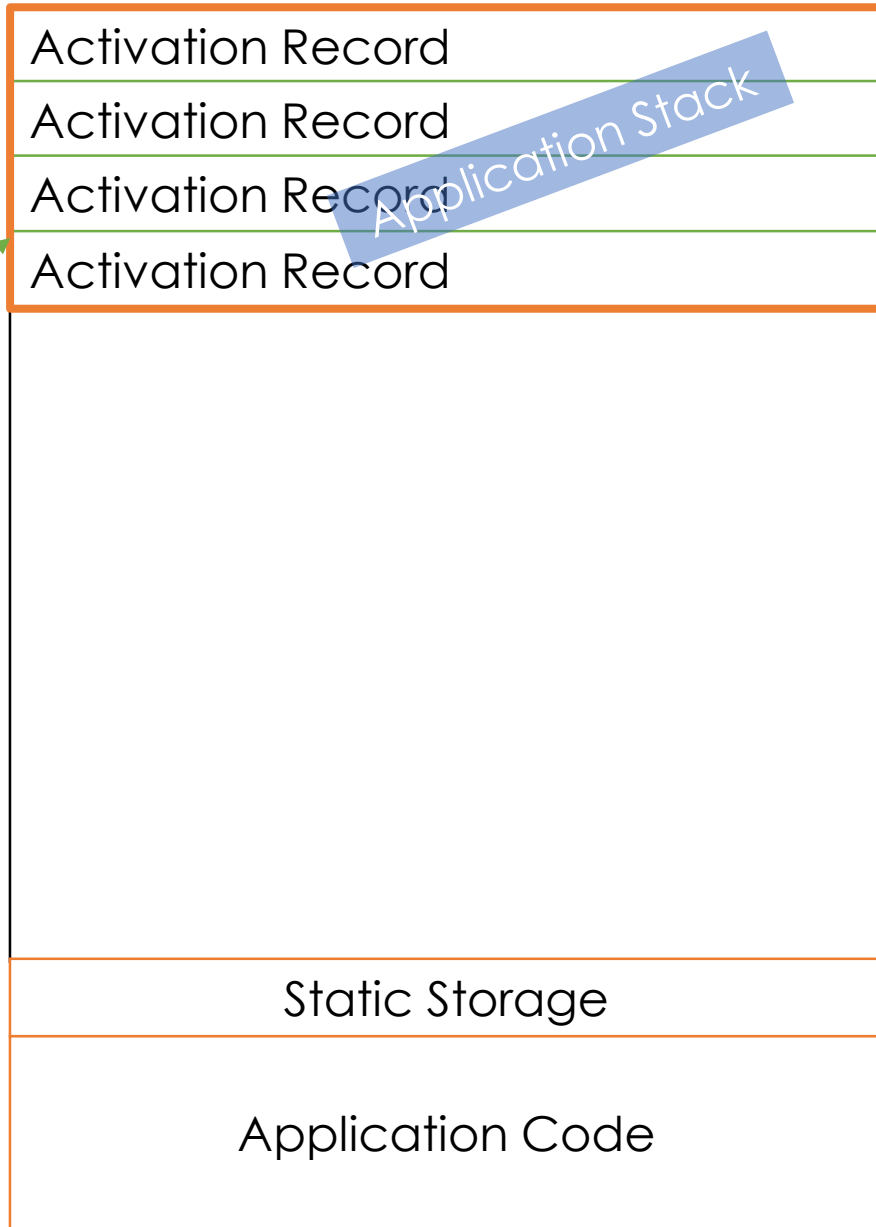


Application Memory

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Application Memory



Application Memory

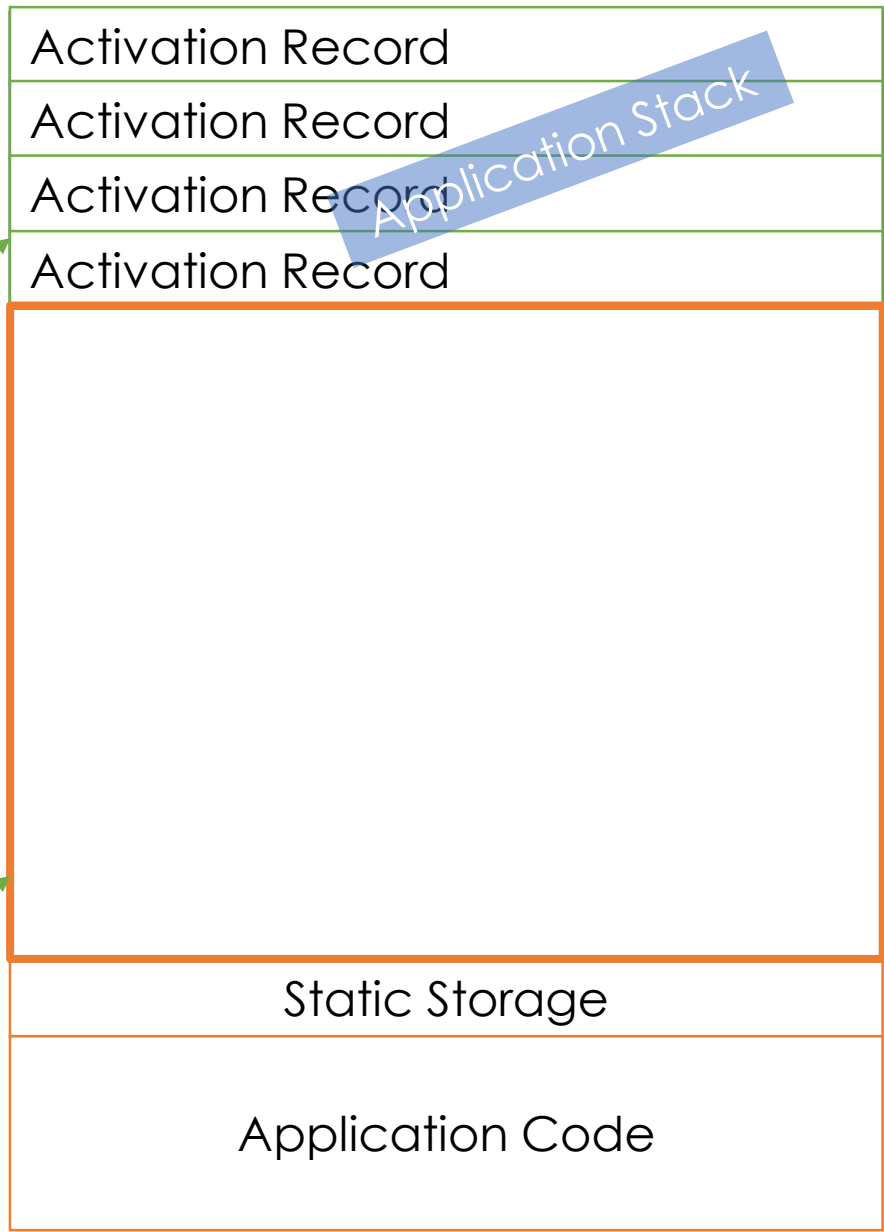
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Function
Parameters and Local Variables

Memory freed when functions
or method ends

Objects instantiated with **new**

Application Memory



Application Memory

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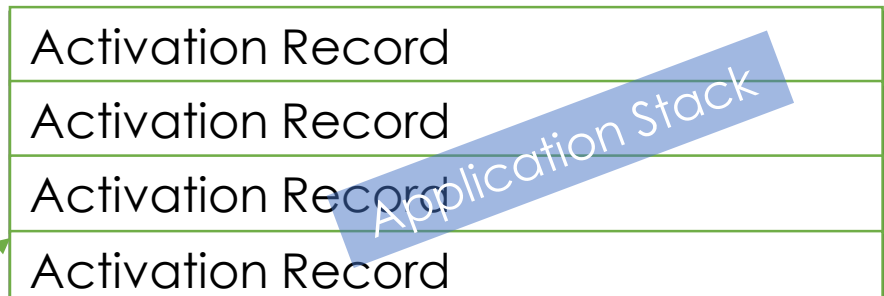
Function
Parameters and Local Variables

Memory freed when functions
or method ends

Objects instantiated with **new**

Memory freed when **delete**
statement is executed

Application Memory



Static Storage

Application Code

Application Memory

```
#include <iostream>
#include <string>
#include "MagicBox.h"
using namespace std;

MagicBox<string>* makeMagicBox(string something)
{
    MagicBox<string>* myBox = new MagicBox<string>(something);
    return myBox;
}

int main()
{
    string gift = "Ring";
    MagicBox<string>* giftBox = makeMagicBox(gift);
    cout << giftBox->getItem() << endl;
    delete giftBox;
    giftBox = nullptr;
    return 0;
}
```

Application Memory

Activation Record
Activation Record
Activation Record
Activation Record

Application Stack

Static Storage

Application Code

Application Memory

```
#include <iostream>
#include <string>
#include "MagicBox.h"
using namespace std;

MagicBox<string>* makeMagicBox(string something)
{
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{
    string gift = "Ring";
    MagicBox<string>* giftBox = makeMagicBox(gift);
    cout << giftBox->getItem() << endl;
    delete giftBox;
    giftBox = nullptr;
    return 0;
}
```

Application Memory

Activation Record
Activation Record
Activation Record
Activation Record

Application Stack

Static Storage

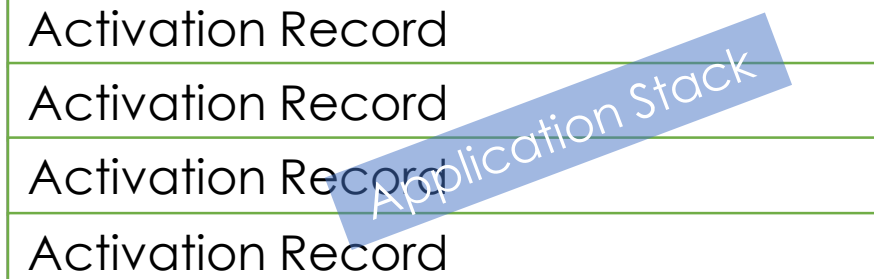
Application Code

Application Memory

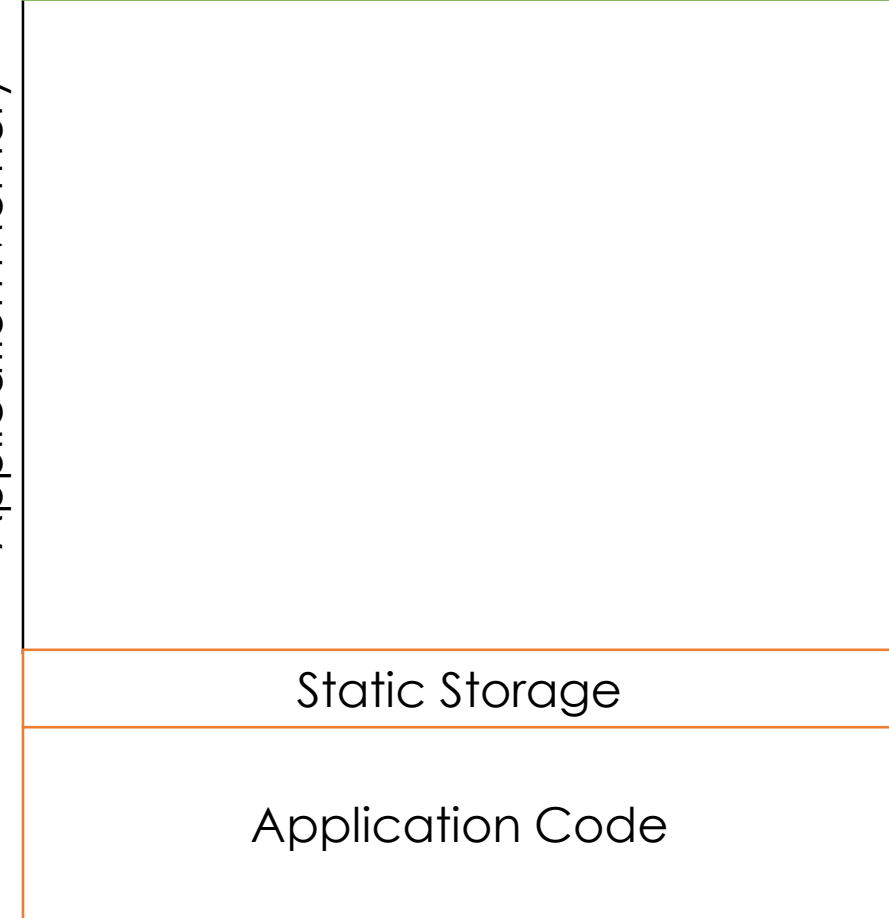
```
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#include <string>
#include "MagicBox.h"
using namespace std;

MagicBox<string>* makeMagicBox(string something)
{
    MagicBox<string>* myBox = new MagicBox<string>(something);
    return myBox;
}

int main()
{
    string gift = "Ring";
    MagicBox<string>* giftBox = makeMagicBox(gift);
    cout << giftBox->getItem() << endl;
    delete giftBox;
    giftBox = nullptr;
    return 0;
}
```



Application Memory

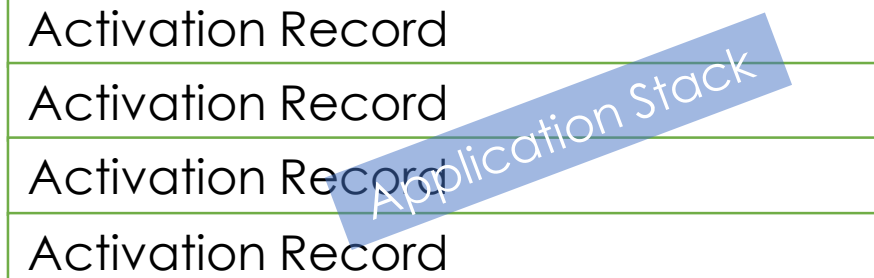


Application Memory

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#include <iostream>
#include <string>
#include "MagicBox.h"
using namespace std;

MagicBox<string>* makeMagicBox(string something)
{
    MagicBox<string>* myBox = new MagicBox<string>(something);
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}

int main()
{
    string gift = "Ring";
    MagicBox<string>* giftBox = makeMagicBox(gift);
    cout << giftBox->getItem() << endl;
    delete giftBox;
    giftBox = nullptr;
    return 0;
}
```



Application Memory



Static Storage

Application Code

Application Memory

```
#include <iostream>
#include <string>
#include "MagicBox.h"
using namespace std;

MagicBox<string>* makeMagicBox(string something)
{
    MagicBox<string>* myBox = new MagicBox<string>(something);
    return myBox;
}

→ int main()
{
    MagicBox<string>* giftBox = nullptr;
    string gift = "Ring";
    giftBox = makeMagicBox(gift);
    cout << giftBox->getItem() << endl;
    delete giftBox;
    giftBox = nullptr;
    return 0;
}
```

Activation Record **main**

gift **Ring**

giftBox

Application Memory

Static Storage

Application Code

Application Memory

```
#include <iostream>
#include <string>
#include "MagicBox.h"
using namespace std;

MagicBox<string>* makeMagicBox(string something)
{
    MagicBox<string>* myBox = new MagicBox<string>(something);
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int main()
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    string gift = "Ring";
    MagicBox<string>* giftBox = makeMagicBox(gift);
    cout << giftBox->getItem() << endl;
    delete giftBox;
    giftBox = nullptr;
    return 0;
}
```



Activation Record **main**
gift **Ring**
giftBox

Application Memory

Static Storage

Application Code

Application Memory

```
#include <iostream>
#include <string>
#include "MagicBox.h"
using namespace std;

MagicBox<string>* makeMagicBox(string something)
{
    MagicBox<string>* myBox = new MagicBox<string>(something);
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}

int main()
{
    string gift = "Ring";
    MagicBox<string>* giftBox = makeMagicBox(gift);
    cout << giftBox->getItem() << endl;
    delete giftBox;
    giftBox = nullptr;
    return 0;
}
```

Activation Record **main**

gift Ring

giftBox

Ring

Activation Record **makeMagicBox**

Something

myBox

Application Memory

Static Storage

Application Code

Application Memory

```
#include <iostream>
#include <string>
#include "MagicBox.h"
using namespace std;

MagicBox<string>* makeMagicBox(string something)
{
    MagicBox<string>* myBox = new MagicBox<string>(something);
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int main()
{
    string gift = "Ring";
    MagicBox<string>* giftBox = makeMagicBox(gift);
    cout << giftBox->getItem() << endl;
    delete giftBox;
    giftBox = nullptr;
    return 0;
}
```

Activation Record **main**

gift **Ring**

giftBox

Activation Record **makeMagicBox**

Something **Ring**

myBox

Application Memory

Static Storage

Application Code

Application Memory

```
#include <iostream>
#include <string>
#include "MagicBox.h"
using namespace std;

MagicBox<string>* makeMagicBox(string something)
{
    MagicBox<string>* myBox = new MagicBox<string>(something);
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int main()
{
    string gift = "Ring";
    MagicBox<string>* giftBox = makeMagicBox(gift);
    cout << giftBox->getItem() << endl;
    delete giftBox;
    giftBox = nullptr;
    return 0;
}
```

Activation Record **main**

gift **Ring**

giftBox

Activation Record **makeMagicBox**

Something **Ring**

myBox

Application Memory

Static Storage

Application Code

Application Memory

```
#include <iostream>
#include <string>
#include "MagicBox.h"
using namespace std;

MagicBox<string>* makeMagicBox(string something)
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    MagicBox<string>* giftBox = makeMagicBox(gift);
    cout << giftBox->getItem() << endl;
    delete giftBox;
    giftBox = nullptr;
    return 0;
}
```

Activation Record **main**

gift Ring

giftBox

Activation Record **makeMagicBox**

Something Ring

myBox

Application Memory

MagicBox Object

item

firstItemStored

Static Storage

Application Code

Application Memory

```
#include <iostream>
#include <string>
#include "MagicBox.h"
using namespace std;

MagicBox<string>* makeMagicBox(string something)
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    MagicBox<string>* giftBox = makeMagicBox(gift);
    cout << giftBox->getItem() << endl;
    delete giftBox;
    giftBox = nullptr;
    return 0;
}
```

Activation Record **main**

gift Ring

giftBox

Activation Record **makeMagicBox**

Something Ring

myBox

Application Memory

MagicBox Object

item Ring

firstItemStored false

Static Storage

Application Code

Application Memory

```
#include <iostream>
#include <string>
#include "MagicBox.h"
using namespace std;

MagicBox<string>* makeMagicBox(string something)
{
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    cout << giftBox->getItem() << endl;
    delete giftBox;
    giftBox = nullptr;
    return 0;
}
```

Activation Record **main**

gift Ring

giftBox

Activation Record **makeMagicBox**

Something Ring

myBox

Application Memory

MagicBox Object

item Ring

firstItemStored false

Static Storage

Application Code

Application Memory

```
#include <iostream>
#include <string>
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    giftBox = nullptr;
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}
```

Activation Record **main**

gift Ring

giftBox

Activation Record **makeMagicBox**

Something Ring

myBox

MagicBox Object

item Ring

firstItemStored false

Application Memory

Static Storage

Application Code

Application Memory

```
#include <iostream>
#include <string>
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    cout << giftBox->getItem() << endl;
    delete giftBox;
    giftBox = nullptr;
    return 0;
}
```

Activation Record **main**

gift Ring

giftBox

MagicBox Object

item Ring

firstItemStored false

Application Memory

Static Storage

Application Code

Application Memory

```
#include <iostream>
#include <string>
#include "MagicBox.h"
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    MagicBox<string>* giftBox = makeMagicBox(gift);
    cout << giftBox->getItem() << endl;
    delete giftBox;
    giftBox = nullptr;
    return 0;
}
```

Activation Record **main**

gift **Ring**

giftBox

MagicBox Object

item **Ring**

firstItemStored **false**

Application Memory

Static Storage

Application Code

Application Memory

```
#include <iostream>
#include <string>
#include "MagicBox.h"
using namespace std;

MagicBox<string>* makeMagicBox(string something)
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    MagicBox<string>* myBox = new MagicBox<string>(something);
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    string gift = "Ring";
    MagicBox<string>* giftBox = makeMagicBox(gift);
    cout << giftBox->getItem() << endl;
    delete giftBox;
    giftBox = nullptr;
    return 0;
}
```

Activation Record **main**

gift **Ring**

giftBox



Application Memory

Static Storage

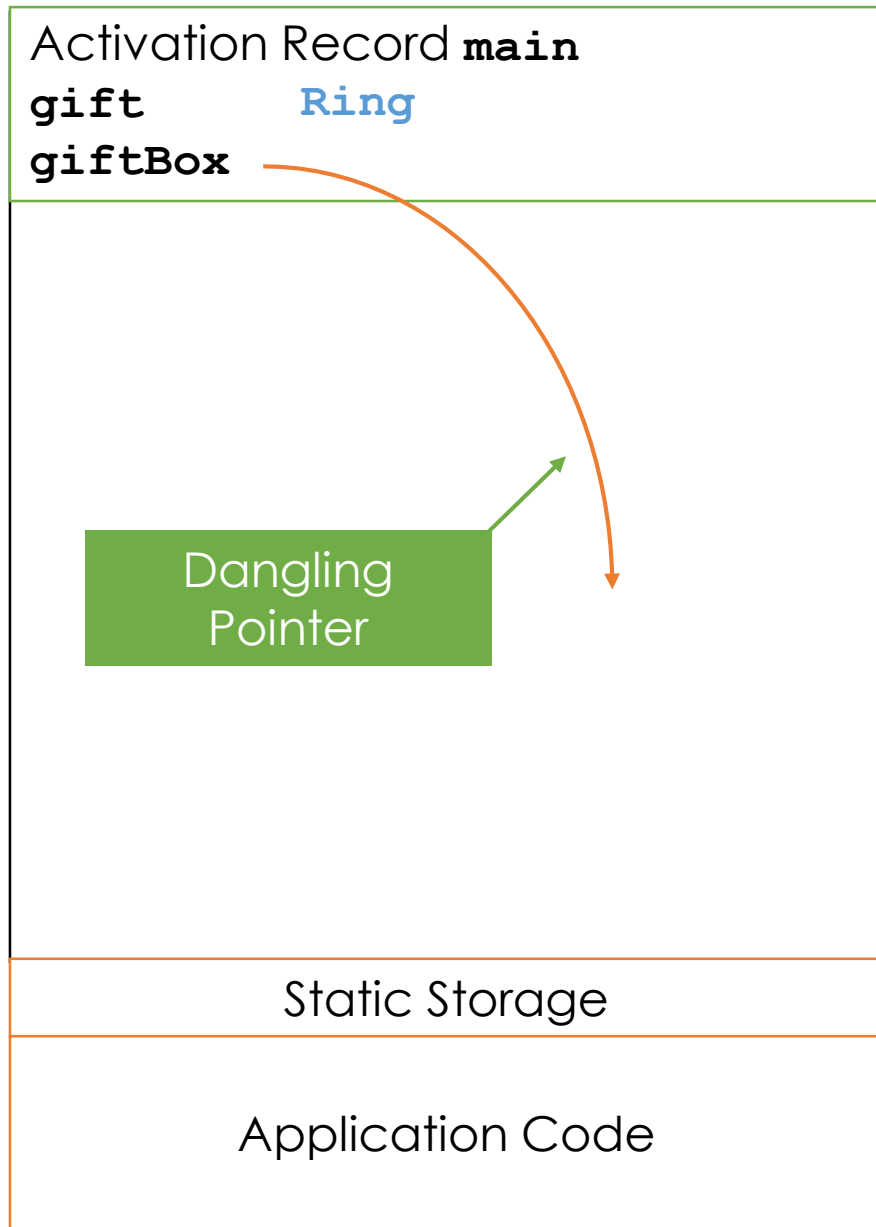
Application Code

Application Memory

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```



Application Memory

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}

int main()
{
    string gift = "Ring";
    MagicBox<string>* giftBox = makeMagicBox(gift);
    cout << giftBox->getItem() << endl;
    delete giftBox;
    giftBox = nullptr;
    return 0;
}
```

Activation Record **main**
gift Ring
giftBox nullptr

Application Memory

Static Storage

Application Code

Application Memory

```
#include <iostream>
#include <string>
#include "MagicBox.h"
using namespace std;

MagicBox<string>* makeMagicBox(string something)
{
    MagicBox<string>* myBox = new MagicBox<string>(something);
    return myBox;
}

int main()
{
    MagicBox<string>* giftBox = new MagicBox<string>();
    string gift = "Ring";
    giftBox = makeMagicBox(gift);
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    giftBox = nullptr;
    return 0;
}
```

Application Memory

Static Storage

Application Code

Application Memory

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Application Memory

Static Storage

Application Code

Application Memory

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    string gift = "Ring";
    giftBox = makeMagicBox(gift);
    cout << giftBox->getItem() << endl;
    delete giftBox;
    giftBox = nullptr;
    return 0;
}
```

Activation Record **main**

gift **Ring**

giftBox

MagicBox Object

item **unknown**

firstItemStored **false**

Application Memory

Static Storage

Application Code

Application Memory

```
#include <iostream>
#include <string>
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    string gift = "Ring";
    giftBox = makeMagicBox(gift);
    cout << giftBox->getItem() << endl;
    delete giftBox;
    giftBox = nullptr;
    return 0;
}
```

Activation Record **main**

gift Ring

giftBox

MagicBox Object

item unknown

firstItemStored false

Application Memory

Static Storage

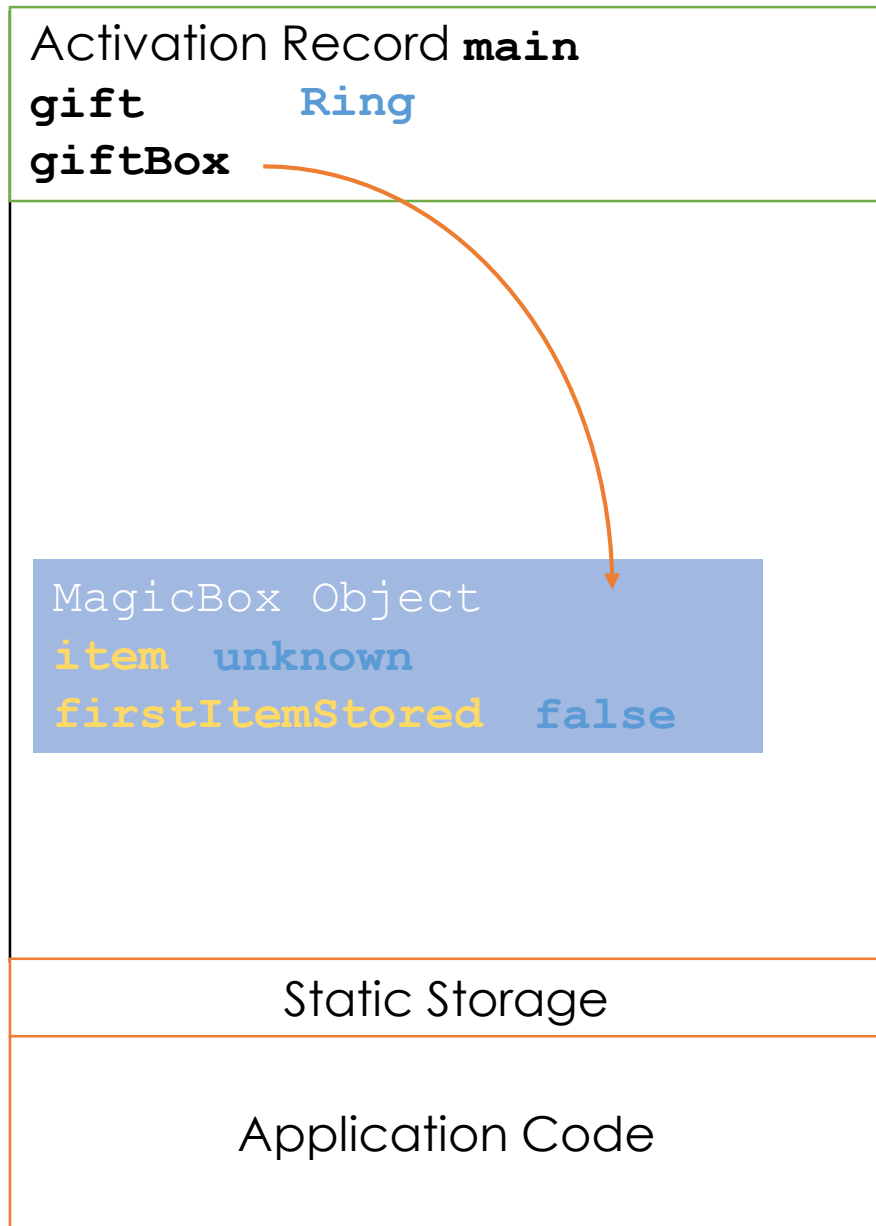
Application Code

Application Memory

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}
```



Application Memory

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    string gift = "Ring";
    giftBox = makeMagicBox(gift);
    cout << giftBox->getItem() << endl;
    delete giftBox;
    giftBox = nullptr;
    return 0;
}
```

Activation Record **main**

gift Ring

giftBox

MagicBox Object

item Ring

firstItemStored false

MagicBox Object

item unknown

firstItemStored false

Application Memory

Static Storage

Application Code

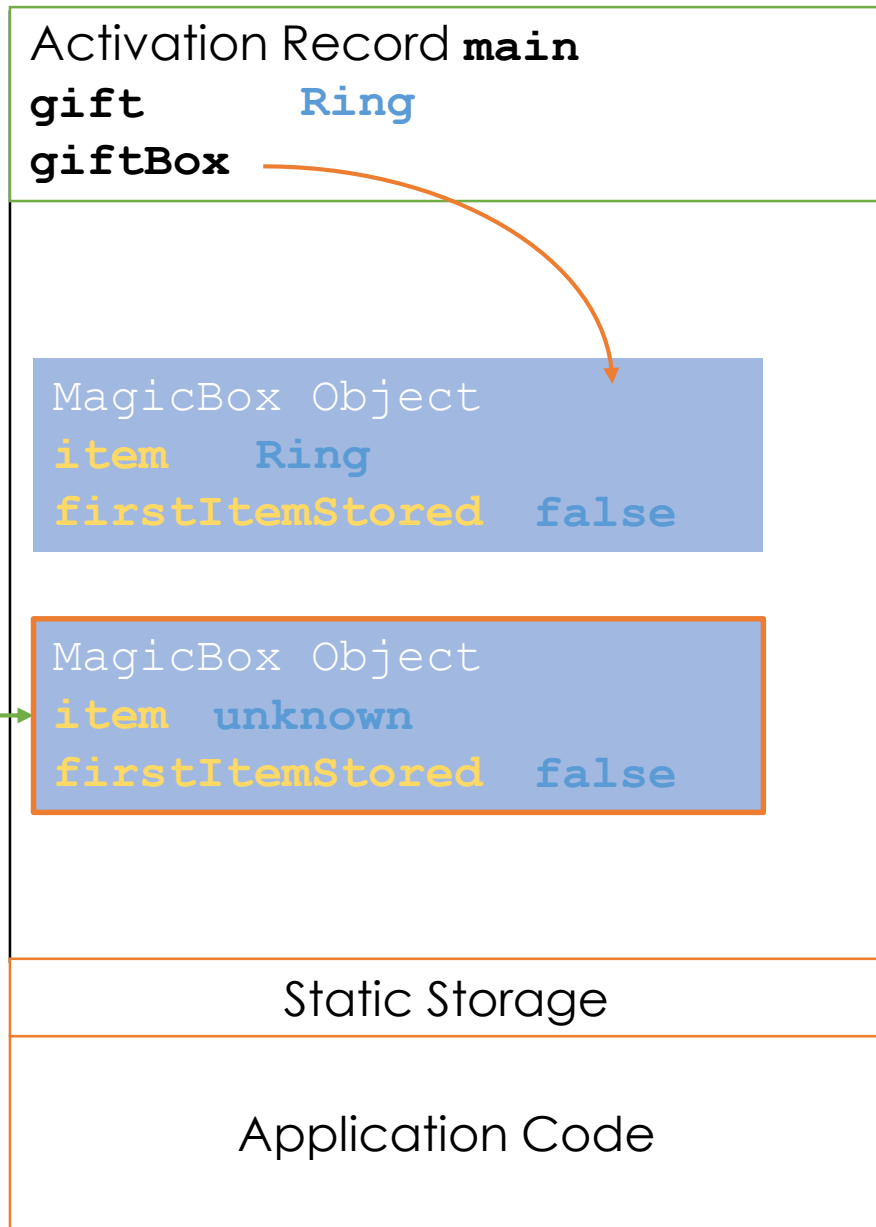
Application Memory

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#include <string>
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MagicBox<string>* makeMagicBox(string something)
{
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    cout << giftBox->getItem() << endl;
    delete giftBox;
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}
```

Memory Leak



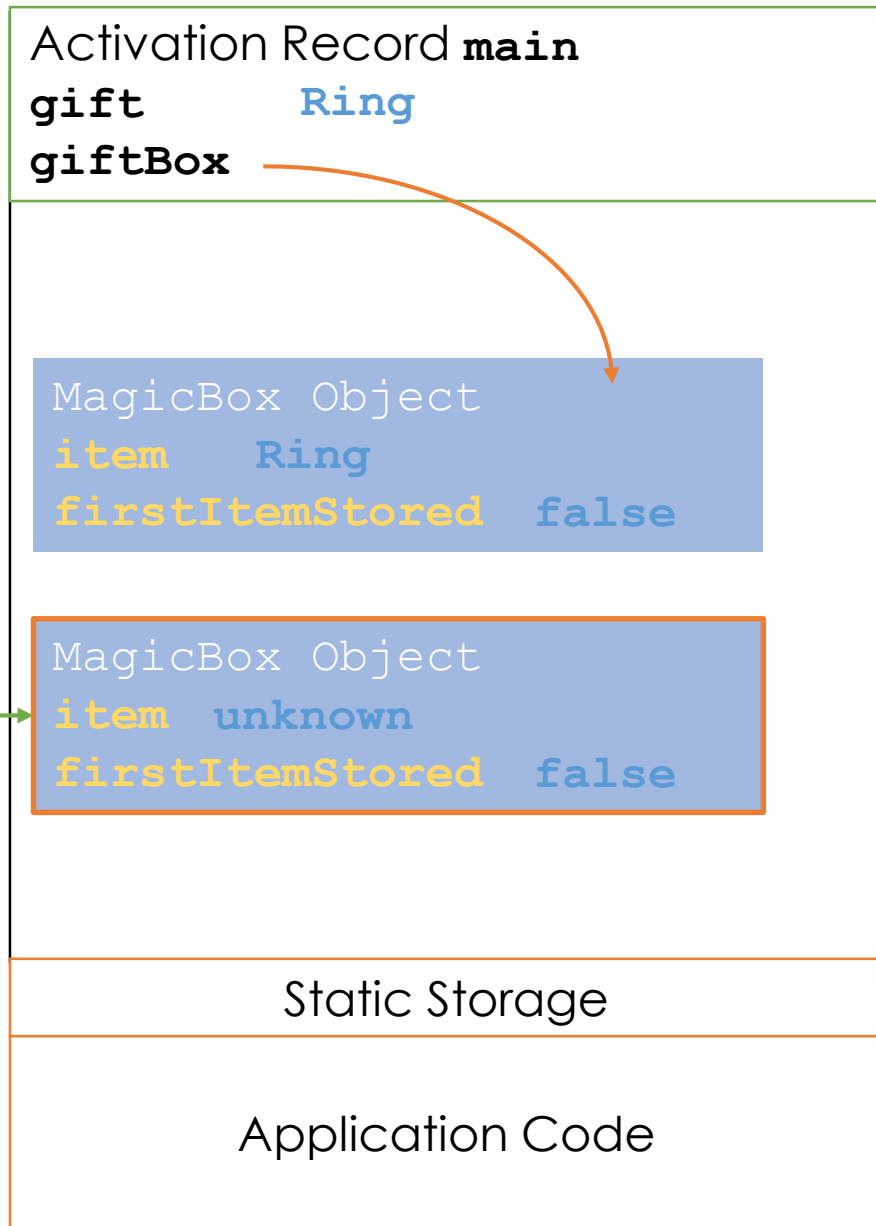
Application Memory

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using namespace std;

MagicBox<string>* makeMagicBox(string something)
{
    MagicBox<string>* myBox = new MagicBox<string>(something);
    return myBox;
}

int main()
{
    MagicBox<string>* giftBox = nullptr;
    string gift = "Ring";
    giftBox = makeMagicBox(gift);
    cout << giftBox->getItem() << endl;
    delete giftBox;
    giftBox = nullptr;
    return 0;
}
```

Memory Leak



Application Memory

```
#include <iostream>
#include <string>
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MagicBox<string>* makeMagicBox(string something)
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    giftBox = makeMagicBox(gift);
    cout << giftBox->getItem() << endl;
    delete giftBox;
    giftBox = nullptr;
    return 0;
}
```

Activation Record **main**

gift Ring

giftBox

MagicBox Object

item Ring

firstItemStored false

Application Memory

Static Storage

Application Code

Application Memory

```
#include <iostream>
#include <string>
#include "MagicBox.h"
using namespace std;

MagicBox<string>* makeMagicBox(string something)
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    MagicBox<string>* myBox = new MagicBox<string>(something);
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}

int main()
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    return 0;
}
```

Activation Record **main**

gift **Ring**

giftBox

MagicBox Object

item **Ring**

firstItemStored **false**

Application Memory

Static Storage

Application Code

Application Memory

```
#include <iostream>
#include <string>
#include "MagicBox.h"
using namespace std;

MagicBox<string>* makeMagicBox(string something)
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    MagicBox<string>* myBox = new MagicBox<string>(something);
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    string gift = "Ring";
    giftBox = makeMagicBox(gift);
    cout << giftBox->getItem() << endl;
    delete giftBox;
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}
```

Activation Record **main**
gift Ring
giftBox

Application Memory

Static Storage


Application Code

Application Memory

```
#include <iostream>
#include <string>
#include "MagicBox.h"
using namespace std;

MagicBox<string>* makeMagicBox(string something)
{
    MagicBox<string>* myBox = new MagicBox<string>(something);
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}

int main()
{
    MagicBox<string>* giftBox = nullptr;
    string gift = "Ring";
    giftBox = makeMagicBox(gift);
    cout << giftBox->getItem() << endl;
    delete giftBox;
    giftBox = nullptr;
    return 0;
}
```



Activation Record **main**

gift **Ring**

giftBox **nullptr**

Application Memory

Static Storage

Application Code

Thank you